

National Ecological Observatory Network

Project Overview

T. Beasley/NEON Project Team

This Talk

- Introduction to NEON
- Operations
- Challenges

NEON: Summary

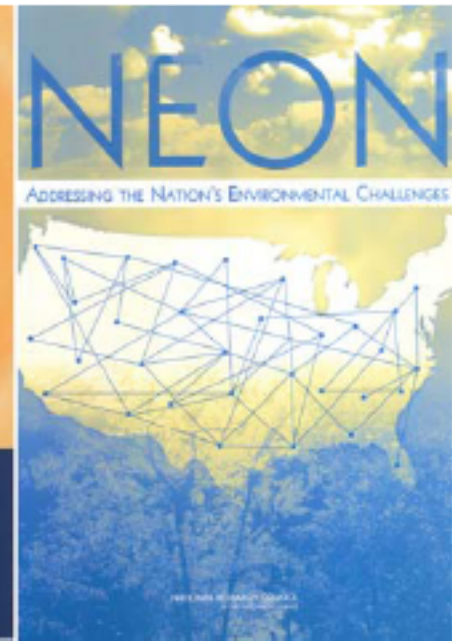
- NEON: A continental-scale ecological observatory.
- Four fundamental science subsystems sampling the drivers/responses of ecological change on spatial scales from microbes to land-masses.
- Infrastructure backbone for other experiments in NEON domains... e.g. STREON – continental scale
- Long-term: Enable forecasting the impacts of climate change, land use change and invasive species on continental-scale ecology.
- Design & development phase; construction late 2010.

Grand Challenges in Environmental Sciences

1. Biodiversity
2. Biogeochemical cycles
3. Climate change
4. Ecohydrology
5. Infectious disease
6. Invasive species
7. Land use



NRC (National Research Council). 2001. *Grand Challenges in Environmental Sciences*. Washington DC: National Academies Press.



NRC (National Research Council). 2003. *NEON: Addressing the Nation's Environmental Challenges*. Washington DC: National Academies Press.

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NEON Questions: Response

- How will ecosystems [of the United States] and their components respond to changes in natural- and human-induced forcings such as climate, land use, and invasive species across a range of spatial and temporal scales? What is the pace and pattern of the responses?

NEON Questions: Feedbacks

- How do the internal responses and feedbacks of biogeochemistry, biodiversity, hydroecology and biotic structure and function interact with changes in climate, land use, and invasive species? How do these feedbacks vary with ecological context and spatial and temporal scales?

RESEARCH @ CONTINENTAL SCALE

NEON Science Requirements

1. The observatory will cover a continental scale, using standardized processes/equipment
2. The observatory will operate for a time period sufficient to detect trends in ecological processes.
3. The observatory will **enable** forecasting the future states of ecological systems
4. The observatory will **enable** study of biodiversity, biogeochemistry, biotic structure and function, climate, hydroecology, invasive species and land use.

GRAND CHALLENGES

Forcing

Climate, Land Use
Invasives

Interactions, Feedbacks

Productivity, Functional Diversity,
Soil Moisture, Habitat Structure, etc.

Responses

Biodiversity, Biogeochemical,
Disease, Ecohydrology

Leads to focused questions that NEON can address on continental scales...

How does land use affect dust mobilization
and what are its impacts?

What are the impacts of current trends
in climate change on disease?

How is land use
affecting biogeochemical cycles?

How is climate affecting biodiversity?

We define a suite of data products that are needed to answer the questions...



And NEON's infrastructure supports science packages that provide the measurements required to produce the data products



NEON Fundamental Science Systems

FSU:	Fundamental Sentinel Unit	Human Observers/Samplers
FIU:	Fundamental Instrument Unit	Automated Instrumentation
AOP:	Airborne Observation Platform	Aircraft Remote Sensing
LUAP:	Land Use Analysis Package	Satellite Remote Sensing +

+ Education mission: Prepare society/scientific community to use NEON data, information, forecasts...

NEON Scientific Deployment (current definition)

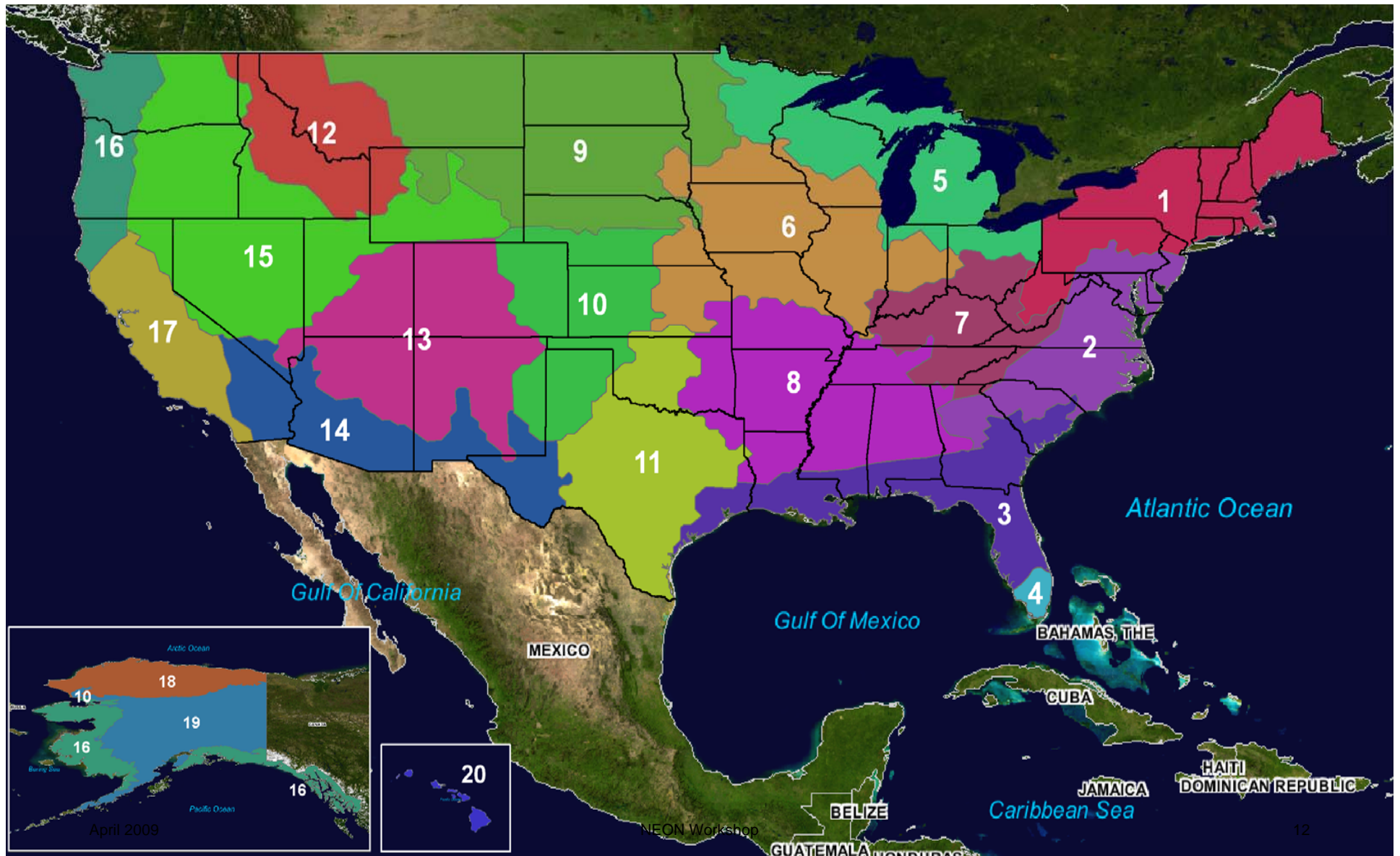
- 20 Domains
- 20 Core sites (wildland)
- 40 Relocatable sites (land-use sites)
- 18 Mobile laboratories
- 3 Airborne Observation Platforms
- Land Use Analysis Package

Spatial Scaling Strategy



NEON Domains

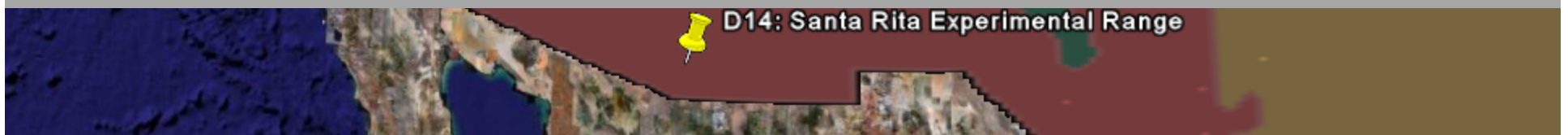
domains		
1 North East	6 Praire Peninsula	12 Northern Rockies
2 Mid Atlantic	7 Appalachia	13 Southern Rockies
3 Southeast	8 Ozarks	14 Desert Southwest
4 Atlantic Neo Tropical	9 Northern Plains	15 Great Basin
5 Great Lakes	10 Central Plains	16 Pacific Northwest
	11 Southern Plains	17 Pacific Southwest
		18 Tundra
		19 Taiga
		20 Pacific Tropical





DOMAIN VARIABLES:

- Number of days above 90°F during the local growing season
- Number of days below 32°F during the local non-growing season
- Precipitation sum during the local growing season
- Precipitation sum during the local non-growing season
- Number of days with measurable precipitation during the local growing season
- Number of days with measurable precipitation during the local non-growing season
- Soil plant-available water holding capacity to 1.5 m
- Total solar insolation during the local growing season, including clouds, aerosols, slope and aspect physiography
- Total solar insolation during the local non-growing season, including clouds, aerosols, slope and aspect physiography



Supporting Facilities for Science and Education

- Chemical analysis facility
- Isotopic analysis facility
- Genomic analysis facility
- BioArchive collections and curation
- Calibration/Validation (cal/val) Laboratory
- Training manuals and courses, colloquia
- Digital field guides, keys, & manuals
- Information for decision support
- (longer term) Data and forecast production facility



Fundamental Sentinel Unit (FSU) - Biotic

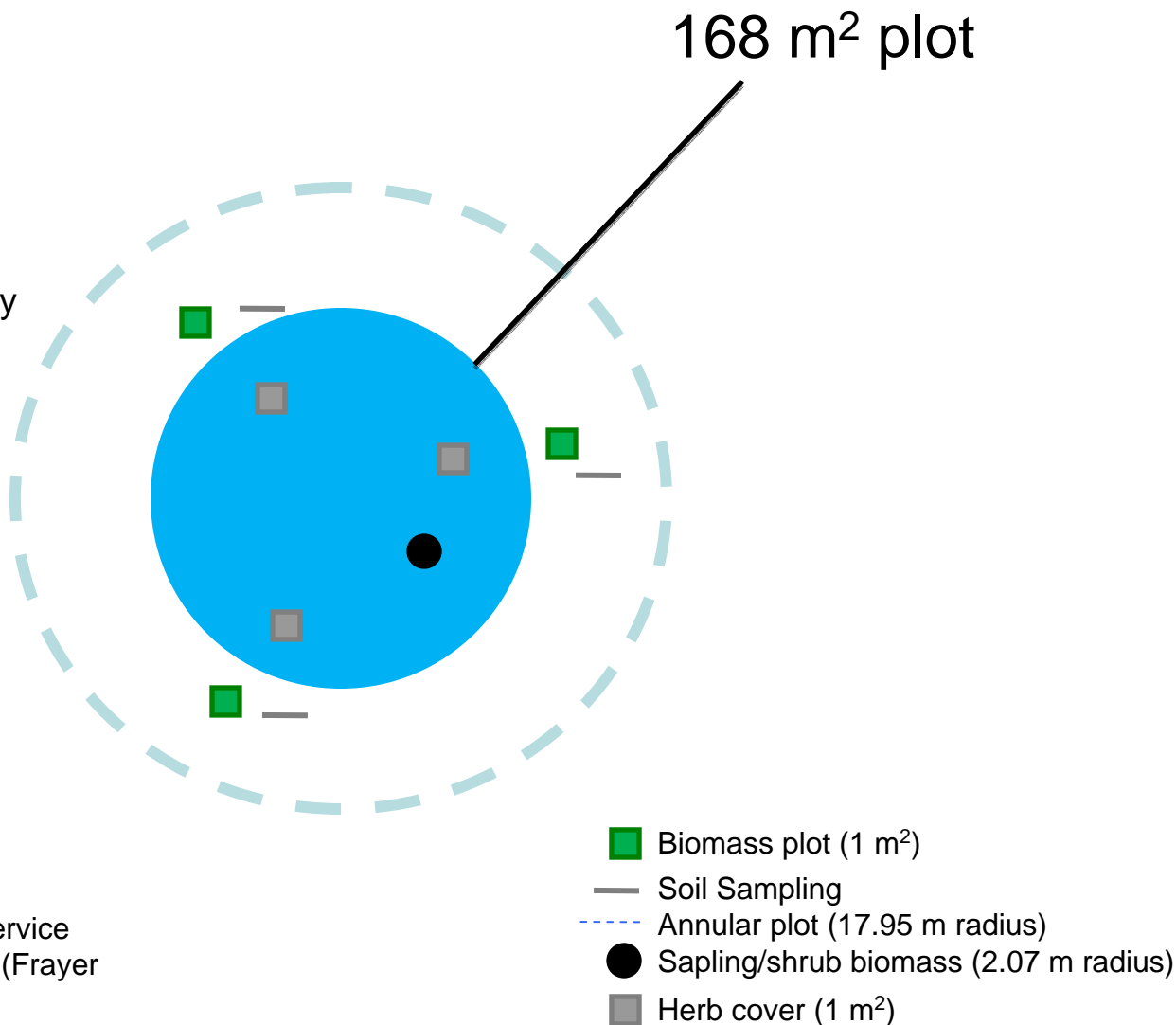
- Supports diverse measurements of
 - Organisms
 - Soils
 - Hydrology
- Uses teams of trained local field crews
 - Supervised by local scientists
 - Specialized in various flora and fauna
 - Nationally standardized and quality controlled

FSU Taxa

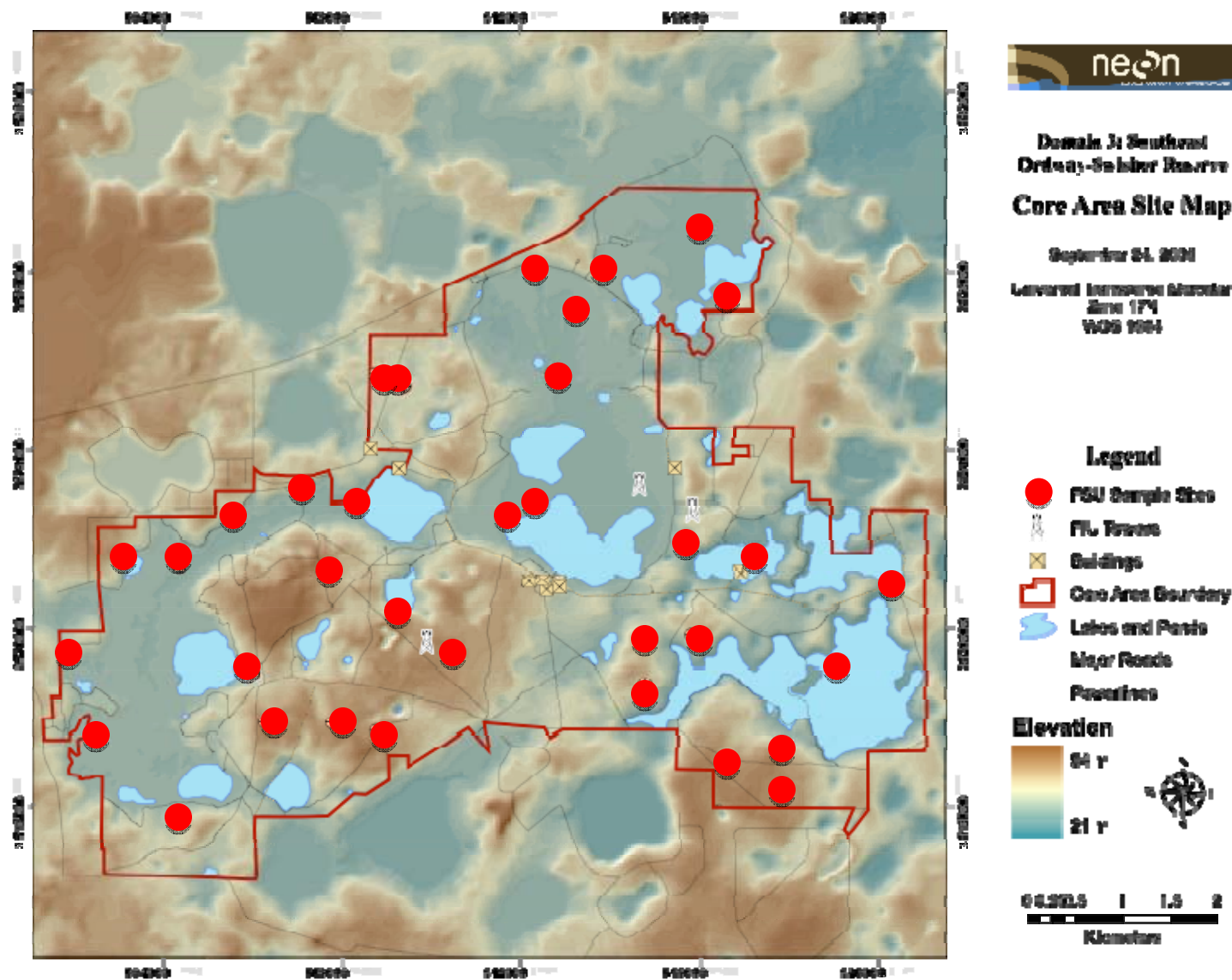
- Vegetation
- Small mammals
- Birds
- Beetles
- Mosquitoes
- Microbes
- Soil chemistry
- Aquatic biology and chemistry

FSU - Plant Biodiversity Plot Design

Vegetation
Small mammals
Birds
Beetles
Mosquitoes
Microbes
Soil chemistry
Aquatic biology and chemistry



Modified from National Forest Service
Inventory and Analysis Program (Frayner
and Furnival 1999)

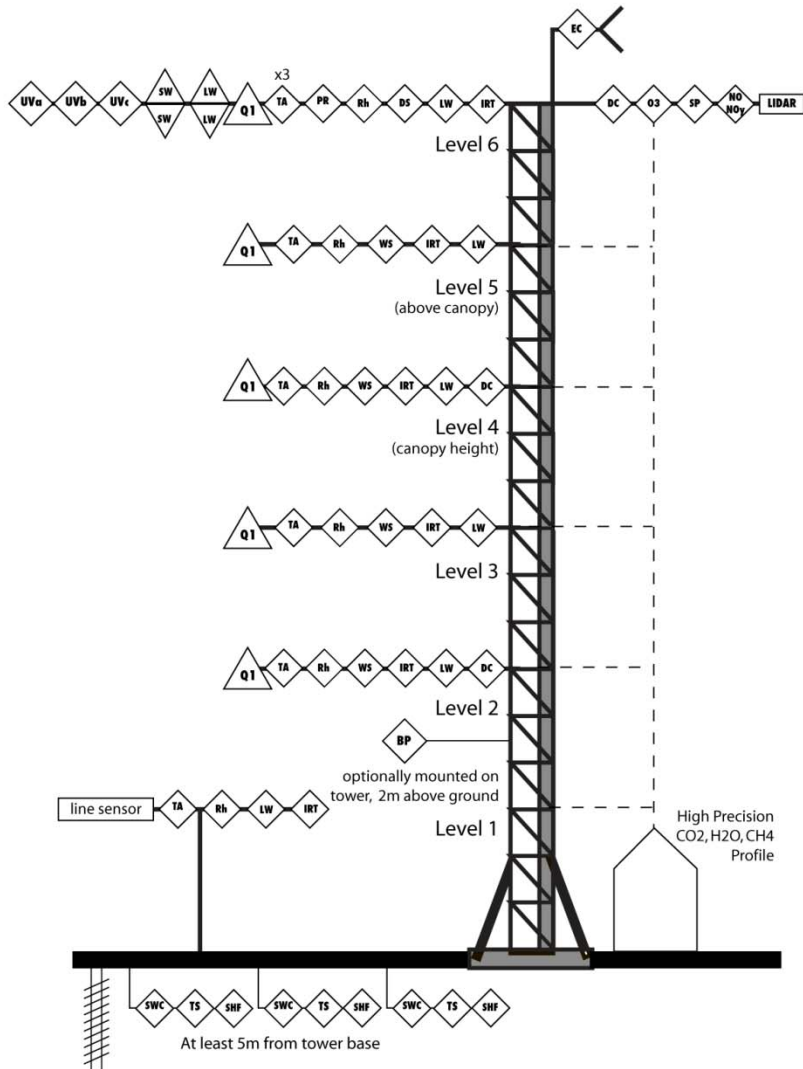


Fundamental Instrument Unit (FIU) - Abiotic

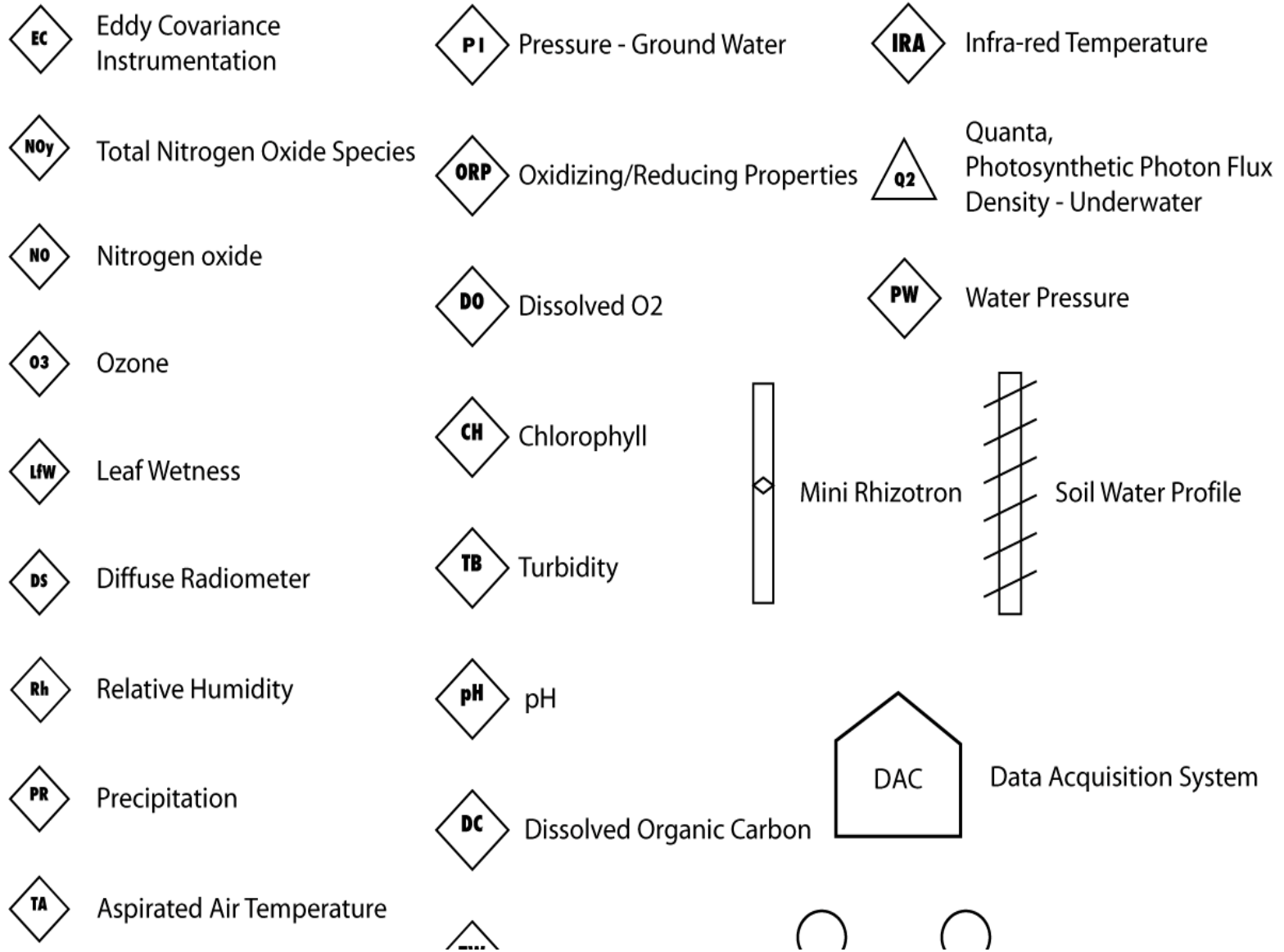
- Advanced Towers,
 - complete set of measurements – environmental, radiation, atmospheric chemistry
 - core representative wildland site – 30yr deployment
- Relocateable Towers,
 - Similar to Advanced
 - Domain/regionally specific, ecologically significant gradients (e.g. land use; invasive species)
 - 5-yr deployment

- Mobile Deployment Platforms
 - Truck/trailer-based tower with associated measurement packages
 - Educational packages
 - Rapid response to disturbance
 - Characterize within and among Domain scales of variance

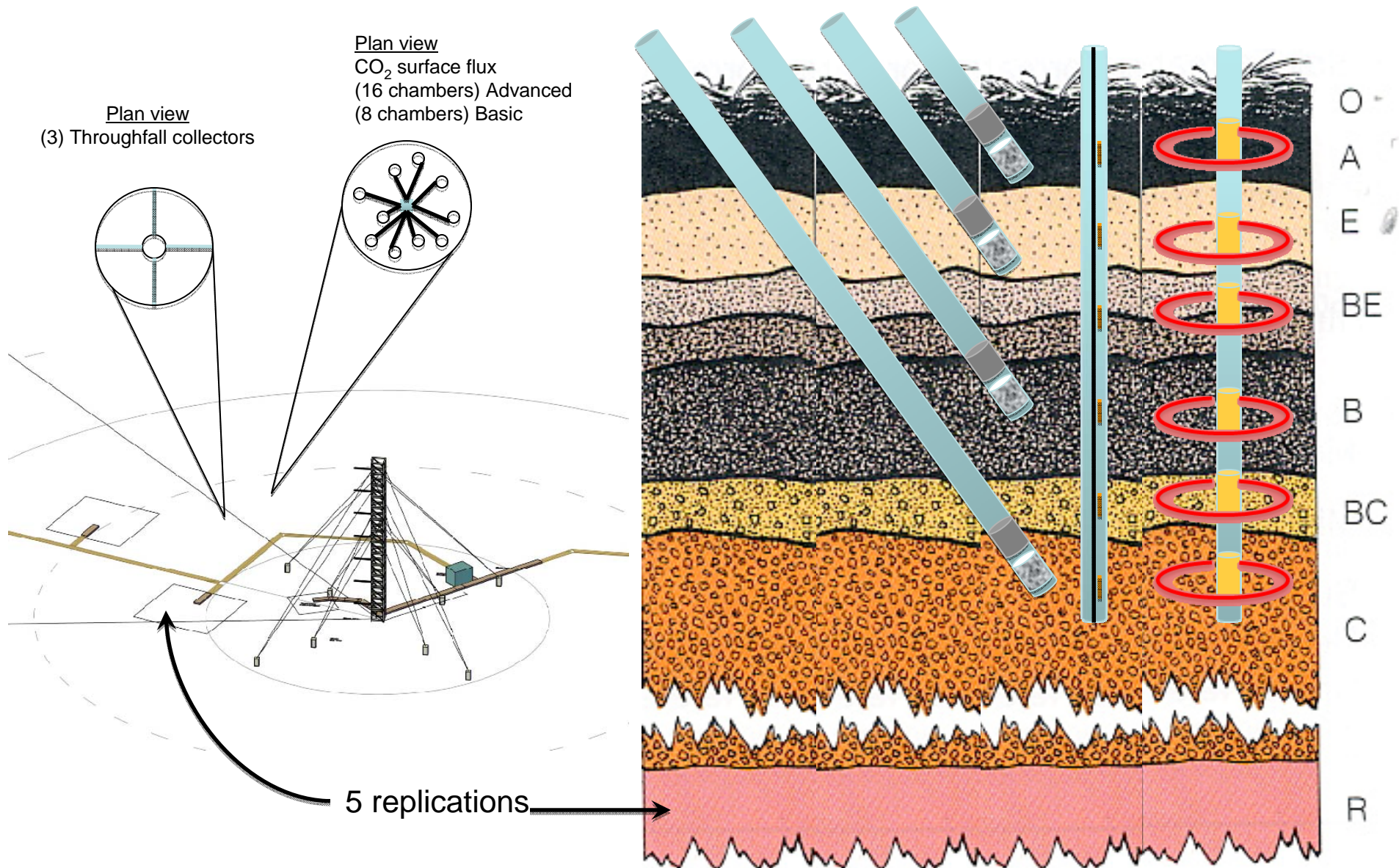
Advanced Tower Design



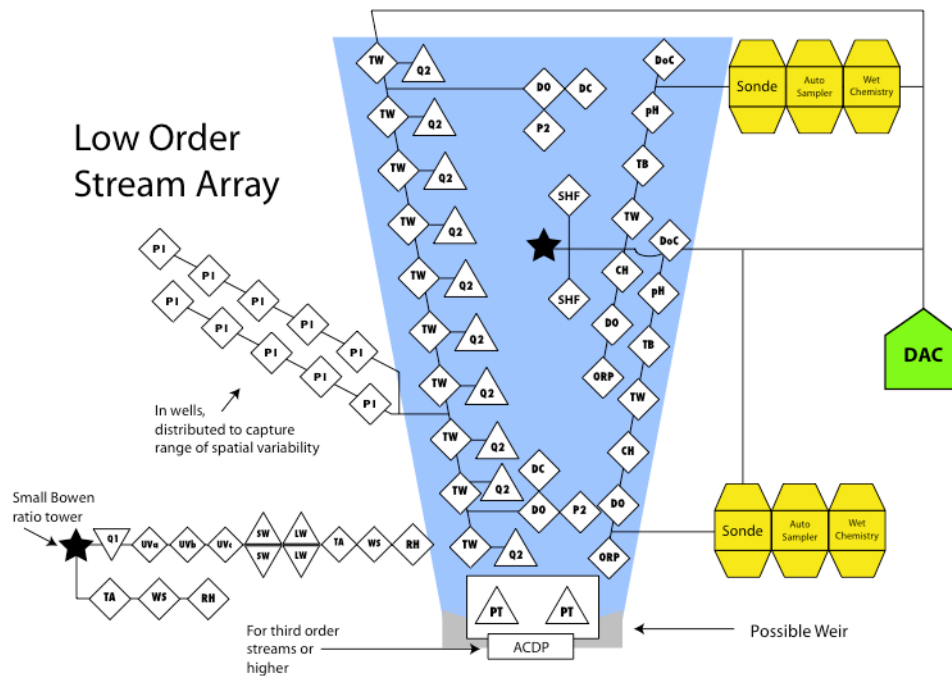
FIU Diagram Legend



Soil Array Design



Aquatic Array Design

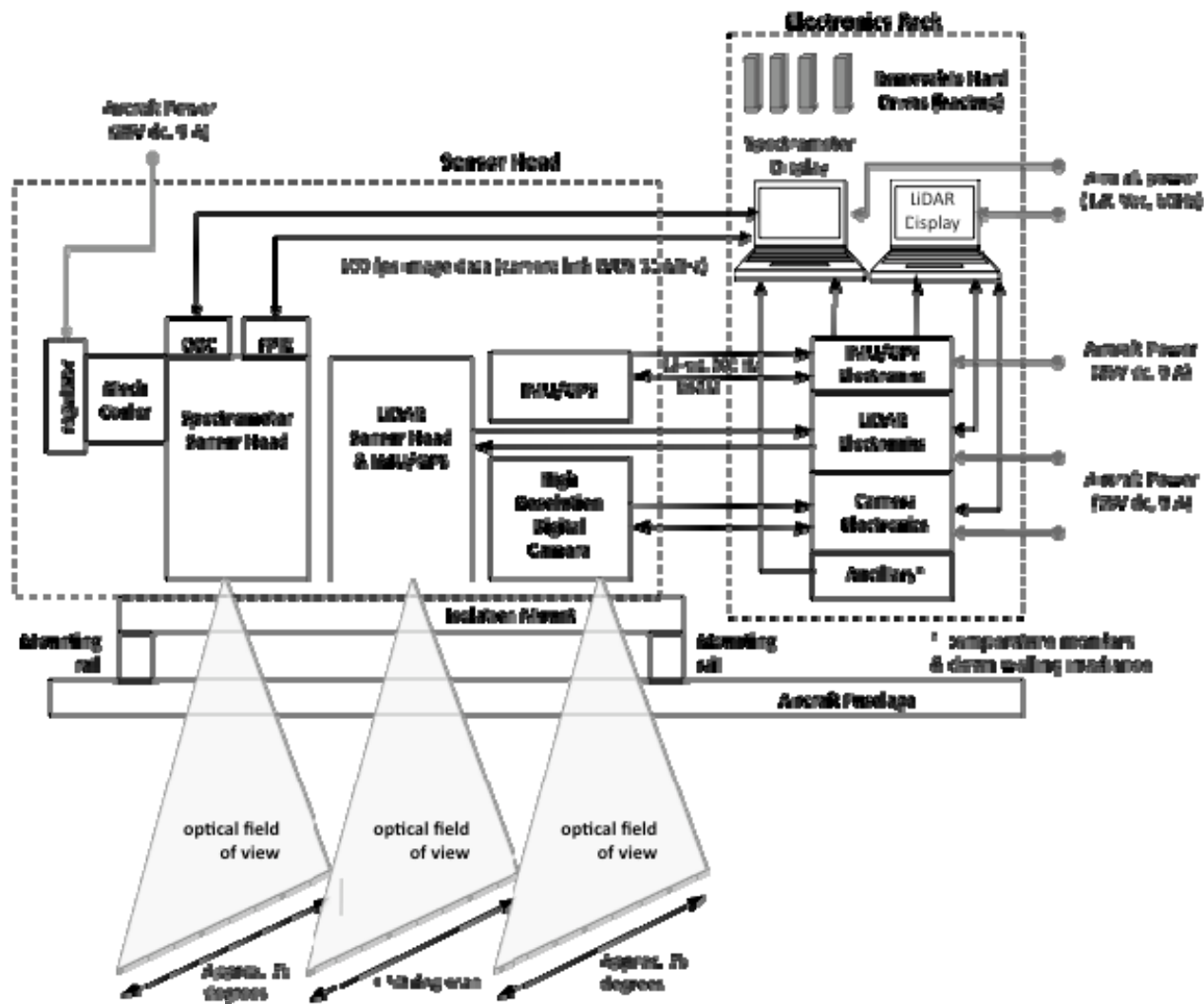


Airborne Observation Platform (AOP)

- Sub-regional scale sampling ($\sim 400 \text{ km}^2$)
- 3 Platforms
- Annual repeat for core and relocatable sites
- Intensive sampling at a subset of sites + TOO
- Vis-IR spectrometer
- Waveform Lidar
- Digital Camera
- Vegetation structure and biochemistry



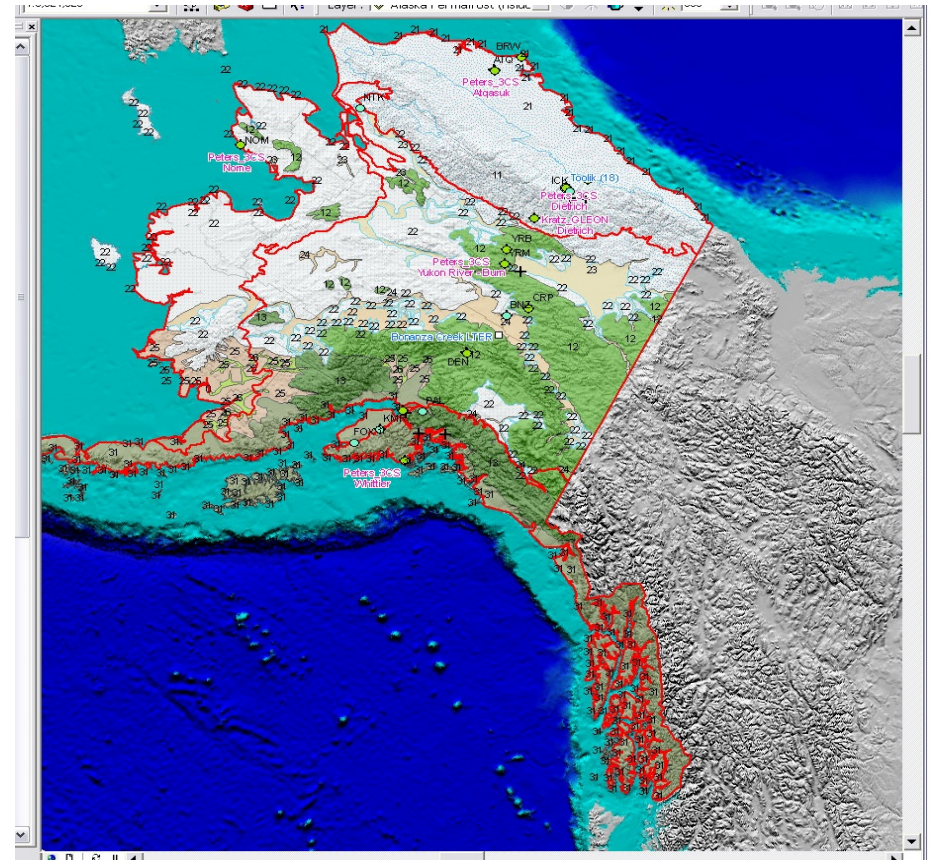
AOP: Remote Sensing Instrument Payload



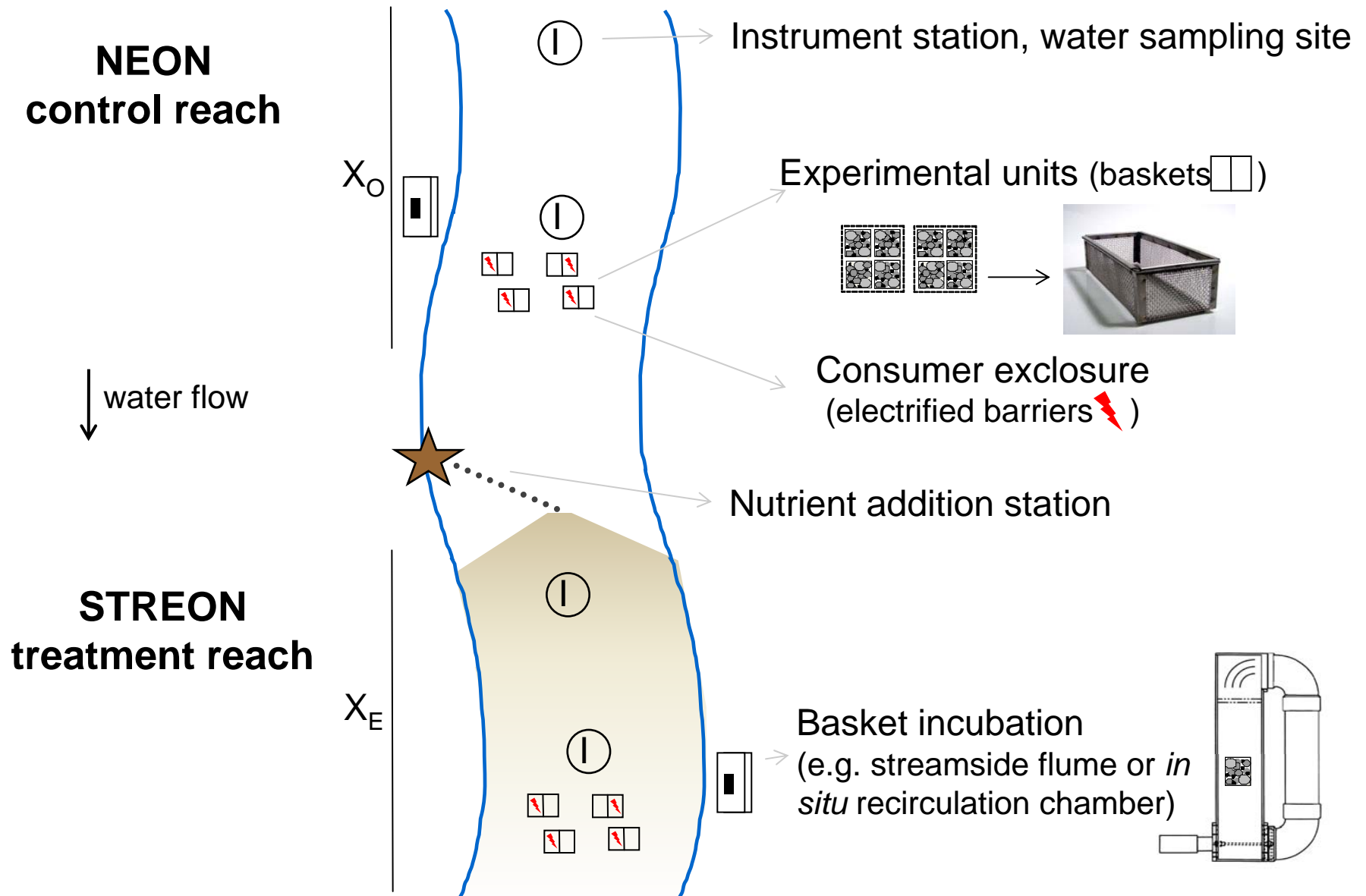
Land Use Analysis Package (LUAP)

Accessing larger spatial datasets.... USGS, NASA etc.

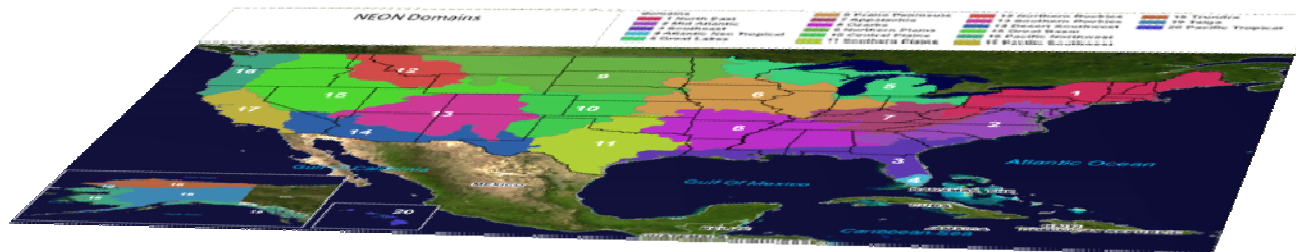
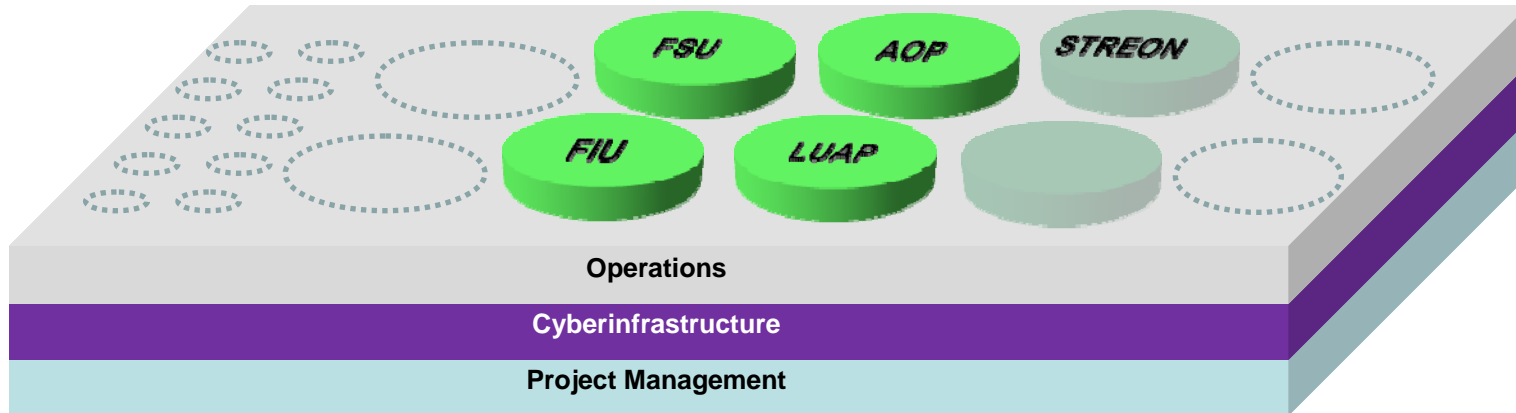
- Continental coverage
- Land cover
- Land use
- Vegetation biophysical properties
- Geographic data including census data
- User interface to facilitate geographic analysis by the non-specialist



STREON Design

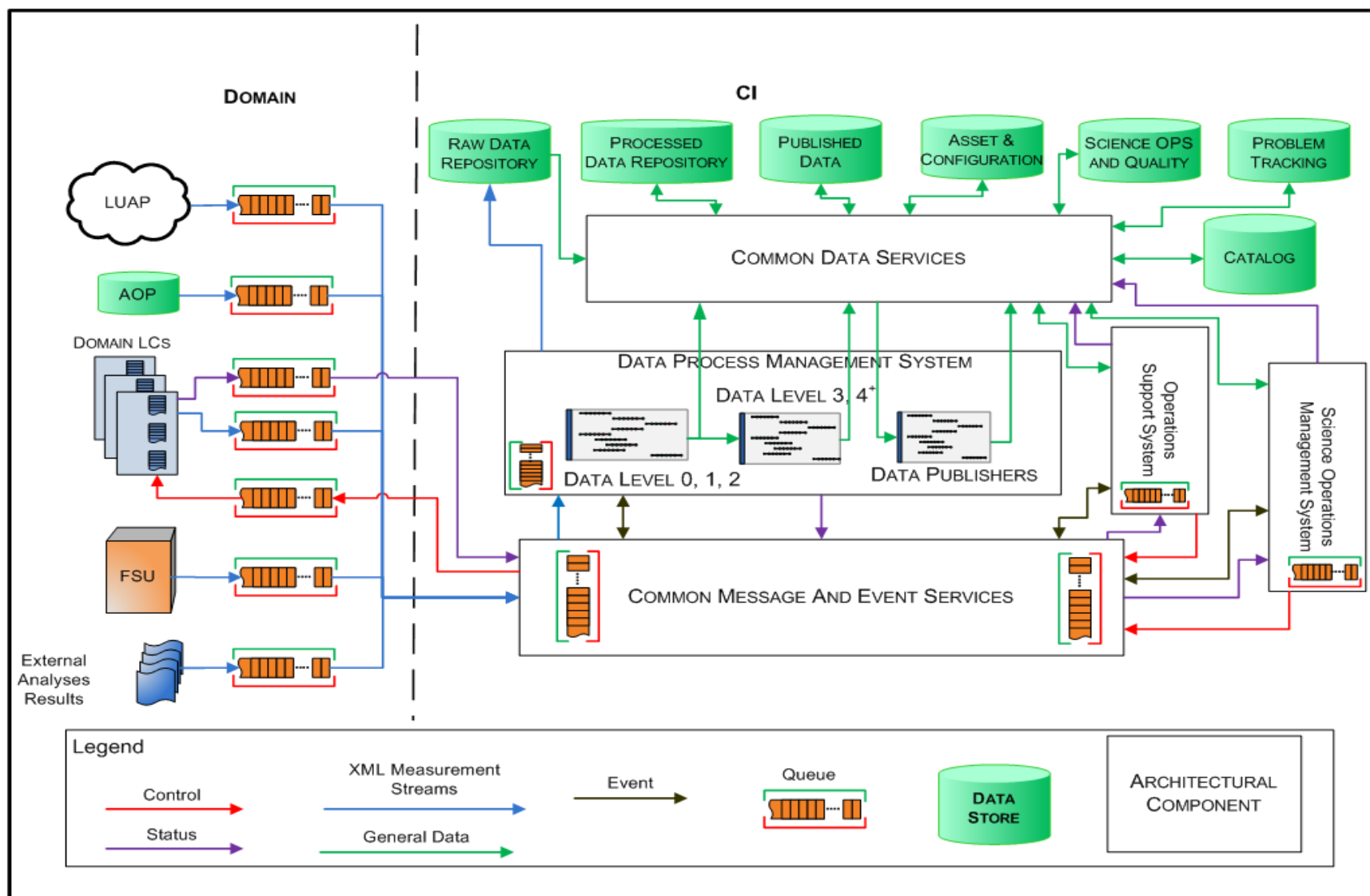


NEON: Research Infrastructure

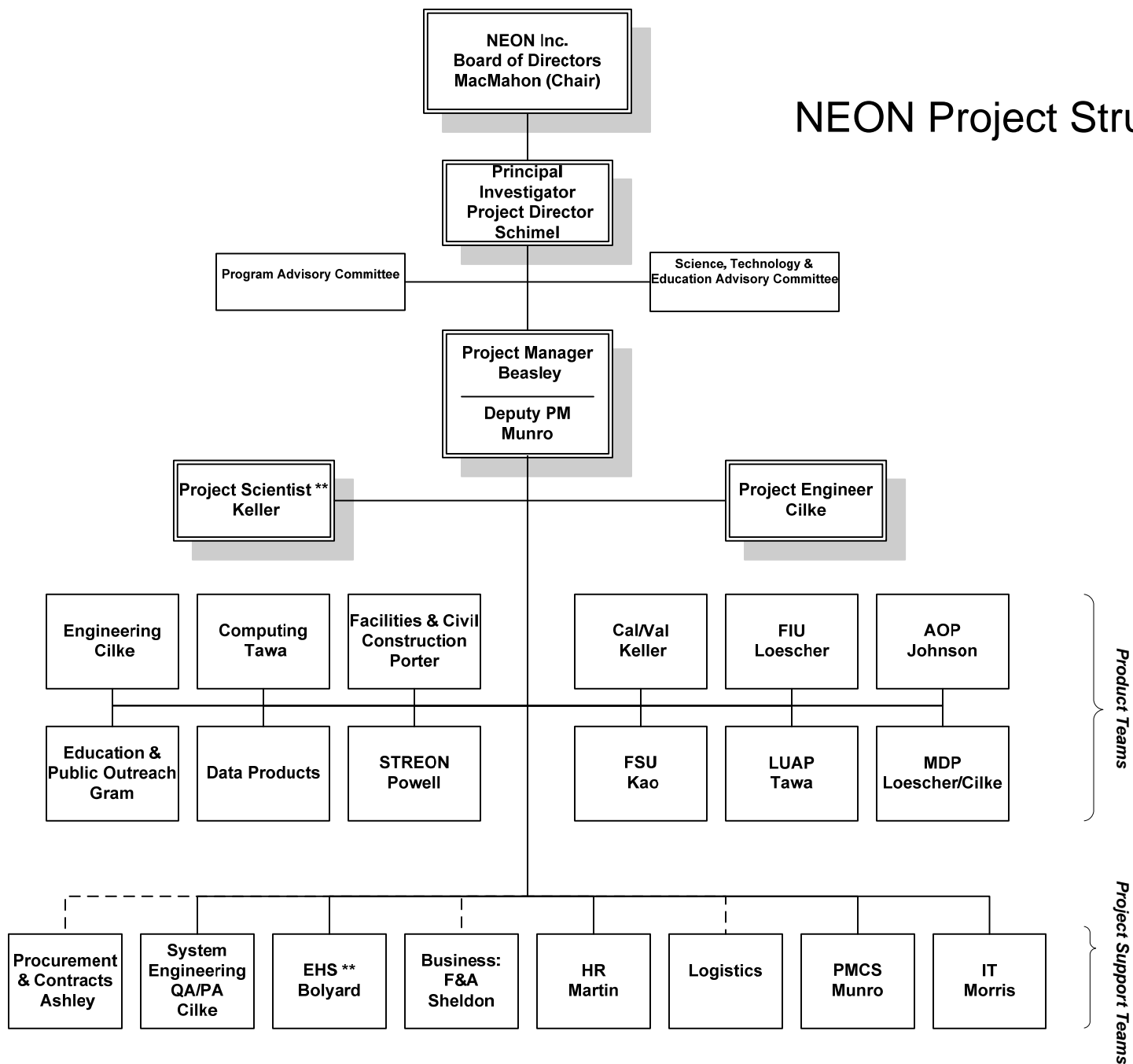


+ NEON Satellite Sites (Don Bowie/SEA)

CI Architecture High Level View



NEON Project Structure



Project Status: 2009

- Two-yr design & development program: May 2008 → 2010
- Company & Project office (~50 people) based in Boulder, CO
- Currently: refining project definition, estimate
- Engineering design contract: domain infrastructure
- Environmental analysis (high-level) underway; site permitting preparations beginning
- Project-wide PDR/Cost Review – June 2009
- Project-wide FDR – Q3/Q4 2009

- Construction funding (normal NSF cycle) – Oct 2010

Operations

- Operations plan in development; based on existing ecological, astronomical observatory models. (similar)
- Key parameters include:
 - Staff in the domains: Domain Model $(DD+5 \times DT+DA+0.5 \times DE) \times 20$
 - Scientific staff for data QA at HQ (~40)
 - Observatory administration (~30)
 - Cyberinfrastructure: inhouse or outsource? (150 TB/yr)
 - Outsourced analyses (FSU) – I,G,C,ID,**Bioarchive** (~Moore's Law)
 - MTBF/MTTR of equipment, infrastructure
 - AOP: fuel, plane availability, scheduling & TOO
 - **Power**/communications to sites
 - *Data policy; Relocatable strategy; MDP policy.....*
- NEON: $\leq \sim \$65\text{M/yr}$

Challenges

- Project hell – NSF/BIO 1st major facility... docs, learning curve
- Environmental review ~ok 62 sites → 3-4/yr
- Difficult financial times...
- **Evolving the community towards C-S Observatory & Science**
 - Biology/ecology – more balkanized than e.g. astronomy, physics - large facilities? (NSF?) Managing community support, expectations, interactions
 - Data products – diverse, complex, evolving - artifacts
 - Standardize technical/cyber approach from the beginning - overhead

Challenges

- Break away from existing resource management models
- Relocatable/MDP/AOP decisions – controlled by NSF, advised by NEON
- Funding for projects to operate on the NEON infrastructure... flows through PI and NEON
- Planning for evolution of the science.... capacity, infrastructure, archiving
- Establishing new linkages between researchers... “a new community”; workshops, funding opportunities, ~social networking

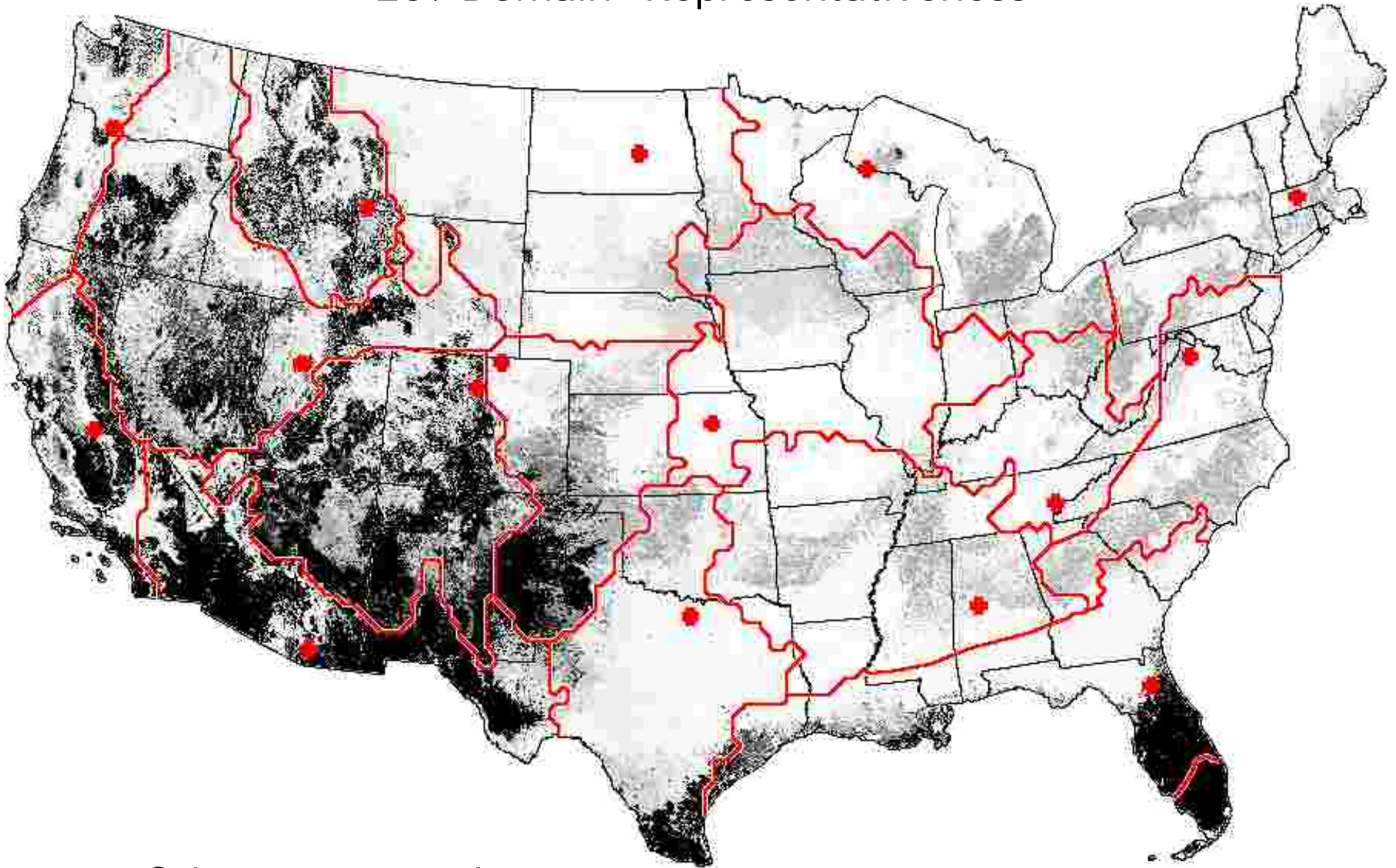
This conference: examine approaches/solutions to similar problems.



NATIONAL ECOLOGICAL OBSERVATORY NETWORK

The National Ecological Observatory Network is a project sponsored by the National Science Foundation and managed under cooperative agreement by NEON Inc.

20? Domain "Representativeness"



20 = Science + pragmatism....

